GO solar CALIFORNIA

CSI RD&D PROGRAM

Cross-Cutting

Grantee:
Electric Power Research Institute

Partners:
Meritage Homes, Southern California Edison, BIRAenergy

CSI RD&D Funding:
$1,485,476

Match Funding:
$2,778,825

Project Timeframe:
2014-2016

RD&D Project Portal:
calsolarresearch.ca.gov/csi/109

Monitoring and Evaluation of a Zero Net Energy Retrofit Home

OVERVIEW AND OBJECTIVES

California's *Long Term Energy Efficiency Strategic Plan,* released in 2008, establishes a policy that all new homes in the state be Zero Net Energy (ZNE) by 2020. As ZNE neighborhoods and communities become more prevalent, there is a need to better understand the impact that these homes will have on the utility grid.

To address this gap, the Electric Power Research Institute (EPRI) team conducted research to evaluate the impacts of a Meritage ZNE neighborhood in Fontana on the local distribution system and to develop mitigation strategies using building energy management systems and energy storage. The team developed ZNE packages including photovoltaics (PV), home energy management systems (HEMS), storage, and demand response (DR) for inclusion in the 20 ZNE homes. They used modeling approaches to predict the impacts on distribution systems and demonstrated how HEMS, DR, and storage can mitigate possible grid issues.

The 20 ZNE homes on two separate transformers were equipped with monitoring and controls of solar and loads to measure grid impacts. To compare the impact of storage, (a) nine homes were also installed with energy storage systems while (b) eleven homes did not include energy storage.

This document provides a brief project description. For more detail on the project and the California Solar Initiative's (CSI) Research Development, Demonstration & Deployment (RD&D) Program, please visit calsolarresearch.ca.gov

The CSI RD&D Program is managed by Itron on behalf of the California Public Utilities Commission (CPUC).

Itron | CSI RD&D PROGRAM MANAGER

METHODOLOGY

The energy-modeling tool BEopt was used by the team to develop a package of energy efficiency features for inclusion in the Meritage homes. Energy storage requirements for the ZNE community were evaluated with consideration for both thermal and electrical storage. The research team developed community-scale ZNE approaches to implement energy storage, HEMS, and DR. These approaches were designed to benefit distribution system efficiency and utility grid stability without sacrificing operational flexibility.

Demand response strategies were demonstrated and evaluated in the ZNE homes to enable greater PV penetration in the bulk power system and to optimize load shapes, Volt/VAR, and fast transient events. The team also estimated the community's feeder impacts. Additional requirements for ZNE homes were identified to inform utility ZNE programs and California Title 24 building energy efficiency standards. The research team also developed modeling approaches for ZNE communities that integrate building modeling and energy storage optimization with distribution models.

RESULTS AND OUTCOMES

The 20 ZNE homes were designed, constructed, and occupied within one year from the start of the research project. The models showed the additional energy efficiency measures reduced the PV system size necessary to achieve ZNE from 5.4 kW to 4.0 kW at a net cost of less than $1,000. The total incremental cost to achieve ZNE was approximately $17,000 per home, an increase of about 4%. The ZNE homes had an average energy cost to customer of $350 per year.

When compared with actual measured data, the models were found to be relatively accurate but did not pick up peak energy use (typically HVAC and water heating) or account for customer behavior. Both factors require higher level resolution to understand grid impacts. Monitored data showed that the ZNE homes had little energy use during periods of high solar production with steep evening ramps. The load shapes for ZNE communities were not cooling driven like non-ZNE homes. Evening peak loads were reduced by 1.6 kW and summer peak loads shifted from the typical 4 PM time frame to 8 PM during heat pump water heater operation. While PV production does not help with mitigation of peaks at those times, storage operation shifted peak loads off of transformer peak loading. These load management strategies will be key to addressing a high penetration PV future.

PUBLIC BENEFITS

Demonstrates technical and economic feasibility of ZNE (including PV) for California new homes.

Helps reduce system cost to ratepayers by offering multiple ways to mitigate grid impacts.

Informs utilities and developers about distribution system architecture, specifications, cost, and interconnection properties.

Fosters a better understanding of how ZNE communities impact the electrical grid and provides technological strategies to enhance grid benefits.